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AUTOPHAGE REUSABLE SSTO LAUNCH VEHICLE

Abstract

Reducing the specific cost of achieving orbit has been an ongoing task for more than fifty years, despite several attempts to mitigate the issue through reusable launchers such as Space Shuttle and Falcon. The reason that this problem appears intractable is the mass penalty associated with reusability. It is well known that the engines take about 60% of launch vehicle cost, and at least a few percentage points of initial mass. A reusable engine is an expensive device, and the vehicles noted above have attempted to combine reusable engines with fundamentally heavy tankage structures. It would therefore be reasonable to design partly reusable systems, with reusability of the expensive engines and control compartments combined with expendable propellant tanks, as was done at Space Shuttle, but this can cause further separation problems and create hazardous impact areas. To solve this problem, we are considering a consumable tankage structure for launch vehicles. The idea is to make the propellant tanks from polymers, and feed them into the engine as fuel together with a conventional oxidizer. The paper presents a version of such an 'autophage' launch vehicle. A polymer fuel tank, with liquid oxidizer inside, would be gradually consumed by an engine travelling along its length from base to tip. A special vaporizer and compressor would gasify and feed the polymeric fuel, while the oxidizer would fed by a turbopump as usual. When the column is finally completely consumed, the engine would be deorbited under active control as a small and lightweight reusable unit. The autophage launch vehicle is feasible as a Single-Stage-to-Orbit (SSTO) design due to the reduced dry-mass of the propellant tank structures, and it can also eliminate impact areas and promote reusability through well-known means of deorbit and parachute landing. We have already achieved effective gasification and self-sustained combustion of polyethylene-oxygen propellant, and are working on the layout of an autophage reusable SSTO vehicle to compete with conventional multistage expendable vehicles. We will therefore present the results of lab-scale test firing of a prototype autophage engine, along with our conceptual design for the vehicle as a whole.